DOCUMENT RESUME

ED 261 669 IR 011 819

TITLE	Communications Satellite Receiver Systems for Public Schools: A Technical Primer.
INSTITUTION	Texas Education Agency, Austin.
PUB DATE	[84]
NOTE	36p.
PUB TYPE	Guides - Non-Classroom Use (055) -- Reports - Descriptive (141)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Broadcast Reception Equipment; *Communications Satellites; Delivery Systems; Diagrams; Elementary Secondary Education; *Information Networks; Programing (Broadcast); School Districts; *Telecommunications

ABSTRACT

Designed to aid school districts contemplating use of some of the telecommunications services now available by satellite, this document contains information on home satellite receiving dishes (Television Receive-Only--TVROs), which can receive radio signals carrying television, sound, and data. This information includes: some factors involved in planning for implementation of a dish; an overview of satellite telecommunications; descriptions of receive-only systems; guidelines for successful programming, including video, audio, and teleconferences; a physical description of the dish; causes of electromagnetic noise; concern for aesthetics; suggestions for site selection, dish aiming, and dish mounts; equipment needed, including feedhorn, wave guide, low noise amplifier (LNA), downconverter, cables, and receivers; TVRO equipment warranty and servicing needs, including licenses, registrations, and costs; and speculations about the technology's future. Additional supporting materials consist of a self test on satellite receiving systems (with answers), a glossary of terms, and a bibliography. Lists of television channels devoted to education, college, teacher inservice, public affairs, ethnic, cultural, and news programming are appended, as well as a discussion of programming management and fees. (JB).

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official N.I.E. position or policy.

ED261669

Communications Satellite Receiver Systems For Public Schools: A Technical Primer

After the original free distribution to authorized institutions, additional copies may be purchased for $1.00 by contacting the Publications Distribution Office, Texas Education Agency. With the increasing demand for educational material, however, the supply at times may be exhausted.

This Texas Education Agency publication is not copyrighted. Any or all sections may be duplicated.

Texas Education Agency
Austin, Texas

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Linda Kemp

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

IR011819

STATE BOARD OF EDUCATION

(State Board for Vocational Education)

JON BRUMLEY, Fort Worth
Chairman of the State Board of Education
District 11

REBECCA CANNING, Waco
Vice Chairman of the State Board of Education
District 9

EMMETT J. CONRAD, Dallas
Secretary of the State Board of Education
District 13

Board Members

VOLLY C. BASTINE, JR., Houston
District 4

MARY HELEN BERLANGA, Corpus Christi
District 2

CAROLYN HONEA CRAWFORD, Beaumont
District 7

CHARLES W. DUNCAN, JR., Houston
District 6

PAUL C. DUNN, Levelland
District 15

MARIA ELENA A. FLOOD, El Paso
District 1

WILLIAM V. McBRIDE, San Antonio
District 5

GERALDINE MILLER, Dallas
District 12

PETE MORALES, JR., Devine
District 3

JOHN MACK PRESCOTT, College Station
District 10

KATHERINE PEARCY RAINES, Cleburne
District 14

JACK STRONG, Longview
District 8

W. N. KIRBY, Commissioner of Education
(Executive Officer of the State Board of Education)

Committees
of the
State Board of Education

Personnel
JOHN MACK PRESCOTT, Chairman
REBECCA CANNING
EMMETT J. CONRAD
CAROLYN HONEA CRAWFORD
PAUL C. DUNN

Finance & Programs
MARIA ELENA A. FLOOD, Chairman
JON BRUMLEY
WILLIAM V. McBRIDE
GERALDINE MILLER
PETE MORALES, JR.

Long-Range Planning
REBECCA CANNING, Chairman
MARY HELEN BERLANGA
EMMETT J. CONRAD
CAROLYN HONEA CRAWFORD
CHARLES W. DUNCAN, JR.
WILLIAM V. McBRIDE

Students
JACK STRONG, Chairman
VOLLY C. BASTINE, JR.
MARY HELEN BERLANGA
CHARLES W. DUNCAN, JR.
KATHERINE PEARCY RAINES

Texas Education Agency

William N. Kirby, Commissioner of Education
Grace Grimes, Deputy Commissioner for Professional Development and Support
Marvin Veselka, Associate Commissioner for Professional Support
Gary Haseloff, Program Director for Educational Technology and Telecommunications

Acknowledgments

The Texas Education Agency wishes to thank the following reviewers for their suggestions and the Wisconsin Department of Public Instruction for reference documents.

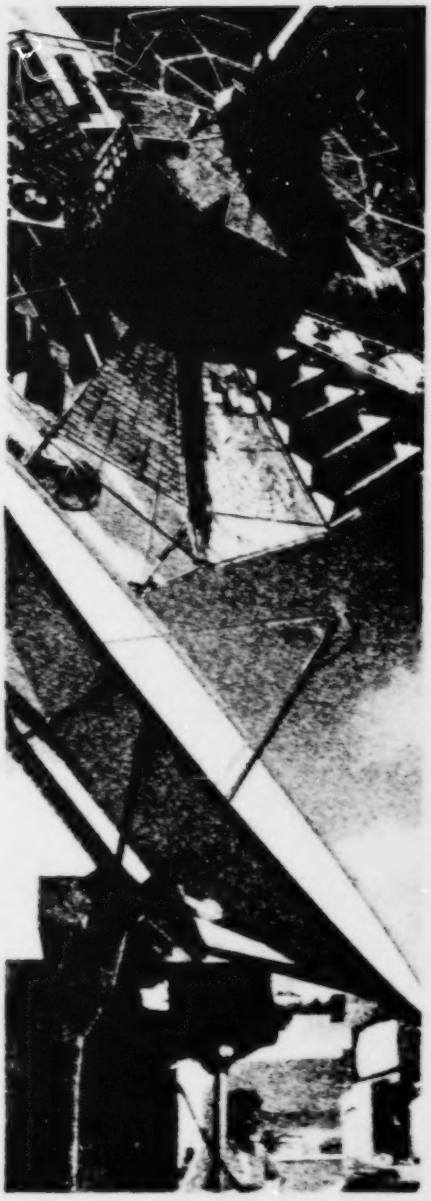
H. H. Bobele, Richardson Independent School District
Dan Bonner, Region XIII Education Service Center
Lynn Dudney, Ector County Independent School District
Fred Mann, McAllen Independent School District
James Taylor, Region XX Education Service Center
Dan Urban, Texas Education Agency
Bill Watson, Scientific-Atlanta and W5UNY Company

Foreword

The information revolution provides educators new opportunities for improving the operation of schools and for the delivery of instruction. Opportunities in telecommunications technology are increasing our access to new services, including instructional and administrative information in a variety of forms. To help meet the new demands for productivity and controlled costs in schooling, the public school system must embrace the capabilities offered by technology.

This document is provided to aid school districts contemplating use of some of the telecommunications services now available by satellite. I believe you will find it useful.

William N. Kirby
Commissioner of Education



Contents

Introduction 1
Planning 1
Satellite Telecommunications 3
Receive-Only Systems 6
Programming 6
The Dish 9
Electromagnetic Noise 9
Aesthetics 11
Site Selection 11
Dish Aiming 12
Dish Mounts 12
The Feedhorn 12
Cables 14
Receivers 14
TVRO Equipment Warranty and Servicing 15
Licenses and Registrations 15
Costs 15
The Future 15
Self-Test and Short Answers 17
Glossary 19
Bibliography 21
Appendix No. One 23
Appendix No. Two 27

Illustrations

Figure 1 2
Figure 2 4
Figure 3 5
Figure 4 8
Figure 5 10
Figure 6 12
Figure 7 16

Communications Satellite Receiver Systems for Public Schools: A Technical Primer

"I believe that the communication satellite can unite mankind."

Arthur C. Clark: The View From Serendip. 1977

Introduction

The growth of communications satellite delivery systems and the resultant availability of information in this country is creating promising opportunities for schools. One of the first technical topics that a school will be concerned about with this type of information delivery technology is the equipment and facilities needed locally. The most obvious piece of equipment is the satellite receiver installation. Commonly called home satellite receiving dishes, or TVROs, which means a television receive-only equipment system, they can receive radio signals carrying television, sound, and data. This document is designed to aid school districts in their investigation of communications satellite receiving equipment.

Planning

Acquisition of equipment will ultimately be one of the lesser costs in the district program to use such services which should be designed to be relevant to each district's goals. School personnel seeking to acquire direct capability to receive information via communications satellite will need to work through a planning process. The first step is to seek answers to why, for what school purposes will you use the messages which are to be received by satellite? At present there is no satellite based state network to serve the Texas public school system. However, private and quasi-private telecommunications networks are being developed which may allow a school district to subscribe to selected services such as management information, inservice training, administrative teleconferencing, bibliographic services, electronic mail, voice mail, and delivery of instruction and materials.

The success of using satellite delivery will ultimately depend more on the quality and usefulness of the content received than upon the equipment. However, a school district should investigate the quality, as well as the capability, of the various TVRO systems. It pays to buy the best professional equipment the district can afford. Backyard, consumer type TVRO equipment, which is designed to be suitable for the home, may not match school requirements.

Long and short term possibilities of telecommunications delivery should be investigated as part of planning. Each district should have concrete ideas and activities established for the system and for training faculty in its use. Management and evaluation procedures should be established for the programming services which may be available. The TVRO may be the end component in the satellite portion of a network, but it is the hub or headend of a school-owned and operated local network. Connecting campuses, libraries, classrooms and student work stations by cable establishes a district's own private network. Such a network may be necessary to allow the district to take full advantage of satellite services as well as other telecommunications services such as community cable. (**See Figure 1.**)

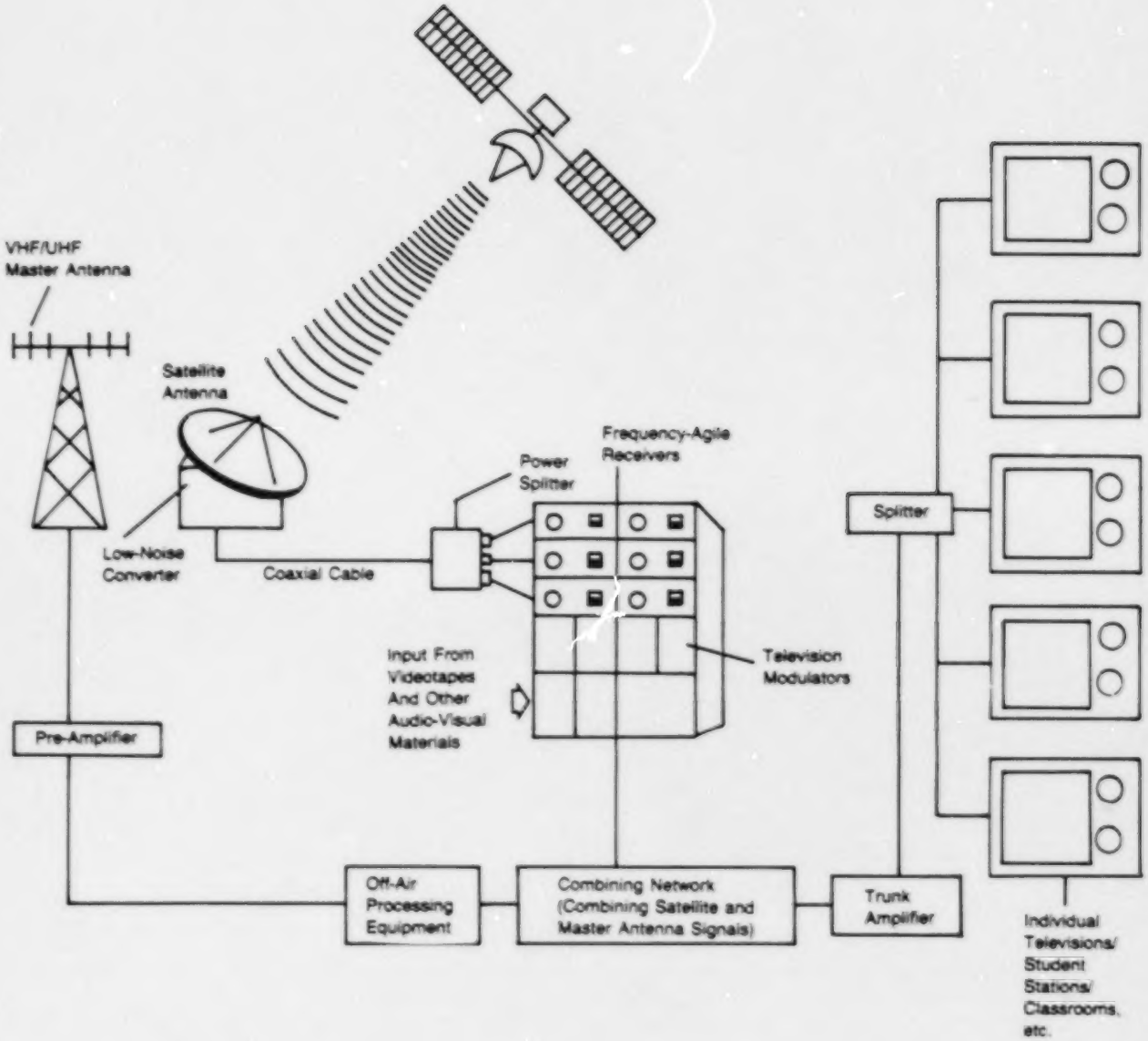


Figure 1
Local Network

A school may not legally be entitled to use all information which can be collected by its satellite receivers. For a more extensive examination of this issue refer to Appendix Two. The district should examine its policy on use of information acquired via satellite, with particular examination of copyrighted material and suitability for school programs. It should take measures to control access to the various kinds of information which may be received for student and staff use. When satellite technology is to be part of the school's information delivery system, it is recommended that responsibility for it be assigned to educational technologists, or media personnel.

Satellite Telecommunications

The basic configuration of a system is shown by **Figure 2.** The receiving facility is the end component of a system of radio-TV telecommunications. Radio signals are sent from the uplink, commonly called an earth station, to a transmitting satellite, or simply "the bird," which is about 23,300 miles above earth. This satellite is in geosynchronous orbit, traveling at a speed that makes it seem to stay in the same spot above earth's equator. The satellite contains equipment which takes signals from an earth station uplink and converts them by electronic devices called transponders into channels for TV, radio, data, and telephone. Usually each transponder has capacity equivalent to one color TV channel, sometimes referred to as a broadband channel, or 2,400 voice channels, often called narrowband. Some satellites have 24 transponders, thus 24 TV channels or several thousand voice or data channels. The satellite transmits its signals back to earth. These usually cover a very broad geographic area. (**See Figure 3.**) The area covered is usually called the satellite footprint. At the center of the footprint area is the maximum signal strength referred to as the boresight. Most satellites serving the United States have a footprint from coast to coast and larger, but some recent satellites can send spot beams. Spot beam capabilities might mean that a state or some other specific geographic region could directly receive the signals, but places outside the perimeter of the spot beam could not.

Presently there are two groups or bands of radio frequencies most used for satellite communications. These are the C-band and K-band. The equipment for using each band tends to differ. Each type may tend to carry different kinds of information which might be used by schools. A school must examine the available programming and services on respective satellites, as well as costs and other factors before deciding on equipment installations.

Downlink signals from satellite transponders operating in the C-band frequencies are relatively weak, about 5 watts power. The size of a receiving dish for C-band ranges from about 6 feet to 20 feet. A size of 10 feet or more is recommended for schools that want quality reception in the C-band. Most television programs via satellite are presently in the C-band. Recent generations of satellite systems have tended to use more powerful transponders operated in the K-band of frequencies. The cost of earth stations and receiving equipment may be less than for C-band.

An earth station uplink which sends signals to a satellite operating on C-band frequencies is normally a very large installation and the signal strength required is relatively powerful. Thus C-band uplinks have been expensive and therefore there are relatively few of them. Recently the cost for certain kinds of uplinks have dropped dramatically.

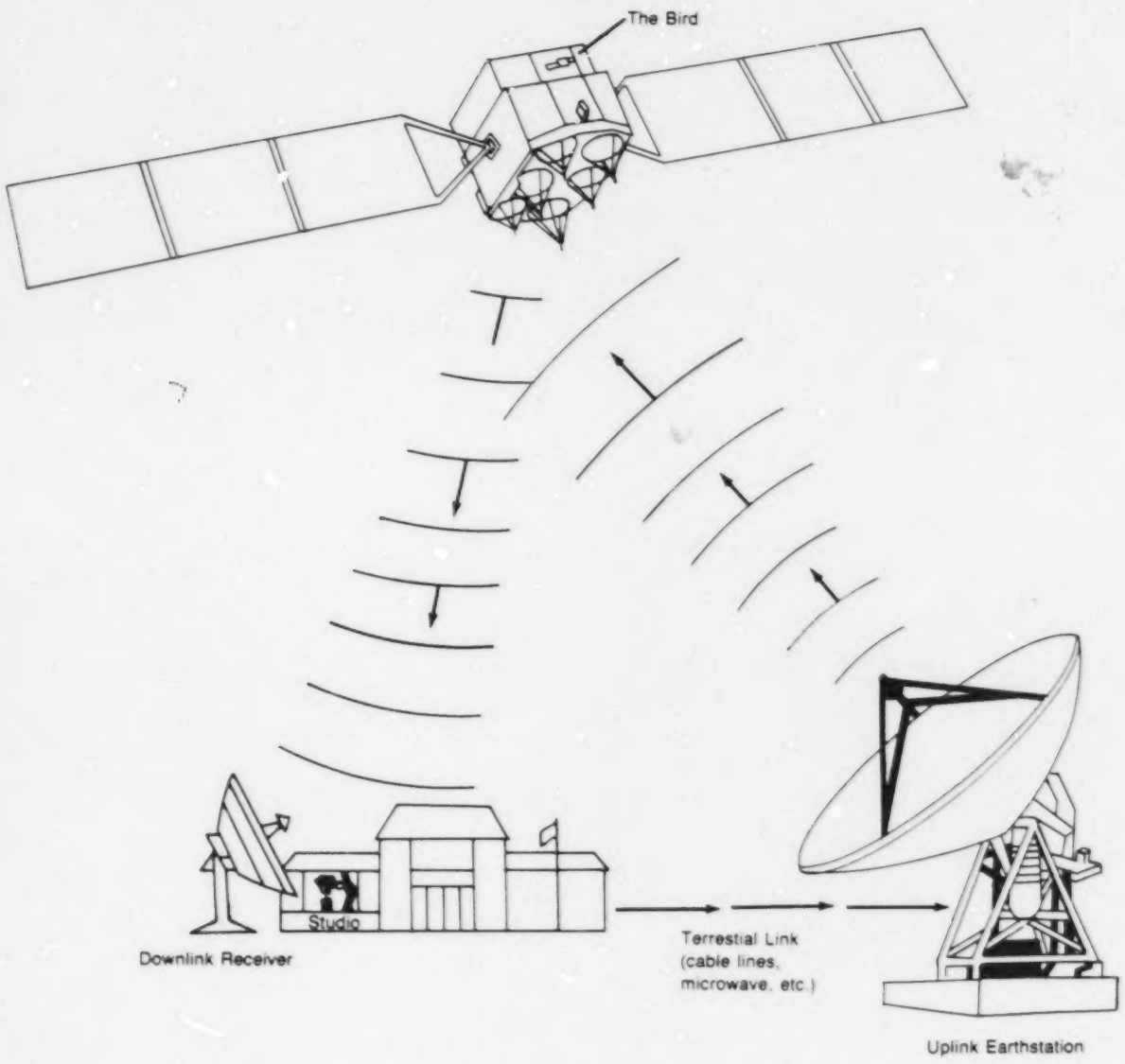


Fig. 2
The communications satellite system consists of all the components necessary to send and receive messages via a satellite.

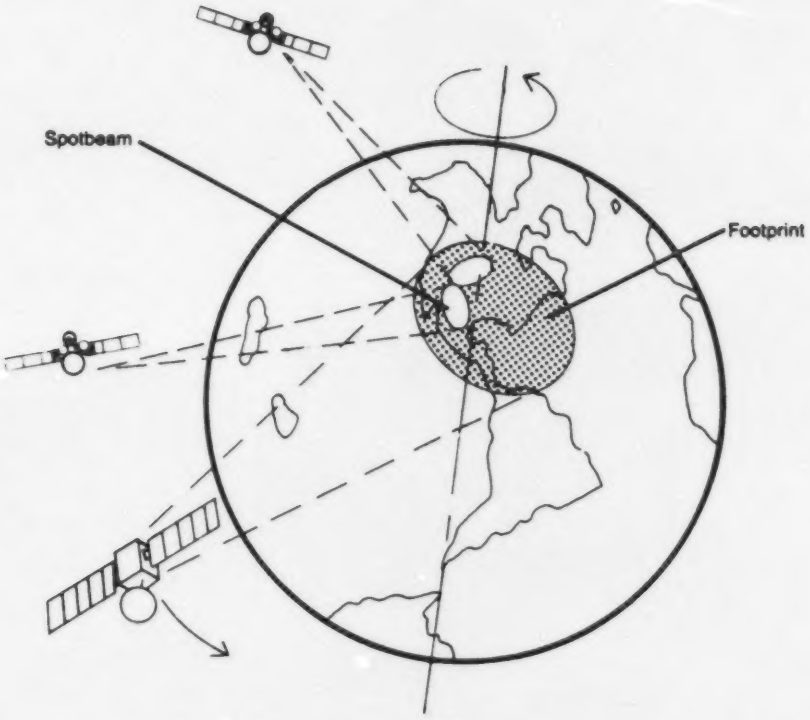


Figure 3
Satellites in geosynchronous orbit may send signals which cover a variety of geographic areas.

Uplinks are normally located close to, but not in, large metropolitan areas. Earth station uplinks are often connected by phone lines, coaxial cable, microwave or fiber optic cable to TV and radio stations, schools, or other message originating places. A school wishing to send a message via satellite must use an earth station uplink. Normally time is purchased for use of uplinks and for transponders. It appears that earth station use, particularly for data and voice, will continue to decline in cost and therefore, become more practical for schools to use to send messages, as well as receive them. Such developments promise to widen the possibilities for school controlled uplinks as well as downlinks, particularly for data and voice transmissions.

Satellite communications may be only one element in a variety of electronic components which can include phone lines, cable television, terrestial microwave links, fiber optic cable, and terrestial radio broadcasts. At present few of these compete on a cost basis with satellites where great distances and multiple use sites are key factors, such as with a statewide school system. **Figure 7** illustrates that satellite based systems may use a variety of telecommunication modes, just as they also involve computer terminals, other types of audiovisual equipment, TV-radio studios, information bases, instructional centers, and so forth.

Receive-Only Systems

Normally a school that uses satellite-transmitted information will install a TVRO (Television Receive Only). The five major elements of a TVRO are:

- dish
- feedhorn
- low noise amplifier
- downconverter
- receiver

A TVRO can be designed to receive telephone, or audio and data as well as television. While experts should be consulted on the specific qualities and performance characteristics of TVRO's, the school personnel should study enough to judge the general performance specifications. The TVRO, as illustrated in Figure 4, may cost from $2,000 to $10,000 if it is used for receiving C-band frequencies. However, a quality TVRO can be bought for less than $4,000. The more recent DBS (Direct Broadcast Satellite) systems use higher radio frequencies than C-band. DBS uses K-band frequencies which require powerful satellite transponders and thus DBS may use TVRO equipment that is less expensive and smaller than C-band receiver equipment. This could result in less expense for installations at school buildings.

Programming

There is no single word which will designate the messages delivered by telecommunications. Information as a term has various meanings. In certain contexts, words such as programming, information, data, software and message are used although they may have nothing to do with telecommunications. For example, "programming" is also used to mean computer programs as well as a process of creating computer software. The term "software" has itself been used to mean computer instructions/programs

and as a generic term for audiovisual materials, even textbooks. This document makes no attempt to establish a single term or meaning. Within the context of telecommunications; programming, information and message have all been used interchangeably. Programming, the traditional term for the most used form of tele-information, television, is also used here to mean all forms of telecommunications messages.

A satellite transmission system is a method of relaying electronic information from one location to another. It is considered similar to telephony, that is, a private carrier. As a private carrier the messages carried can be considered proprietary and thus protected by law. While information sent by transponders may be available at no cost to schools, educators who wish to use satellite programs in their classrooms should first receive permission from the entity responsible for providing the programming. Check to see if the information is in the public domain, or otherwise freely available to the school district. This is particularly applicable to copying or duplicating programming.

Using satellite programs requires careful planning in identifying what is available and how it can be used for individual as well as group instruction. Information which is copyright restricted might need to be approached somewhat differently from the normal uses of an instructional television program or film. For example, instead of using a total program, the teacher may select only small portions of programs to use for a particular objective. Or, a news event may be used one time, or individual students may be assigned to use satellite programming as part of their research assignments.

Each district should take steps to ensure that the programming which students have access to is appropriate. Just as with other instructional materials, the range of programs available via satellite may not be suitable for a variety of reasons. Therefore, the district should check its selection practices as well as taking steps to control which satellite channels and programs students can access on their own.

Video: There are more than a dozen domestic (non-military) satellites, over North America. These send the equivalent of more than 140 television channels to earth including information from NASA, C-span, PBS, The Learning Channel and many other sources. (**See Figure 4 and Appendix One**) Each school will have to investigate costs and the programming available from satellites. Channels and listings change regularly. Learning resources center staff may be able to identify sources. Some telecourses contacts are listed in Appendix One. Periodicals which deal with communications satellites and program schedules are listed in the Bibliography.

Audio: A variety of audio messages are transmitted via satellite. Audio may be carried as a subpart of television channels or on channels called narrowbands. To be picked up, a receiver which is tunable to specific subcarrier frequencies must be used. News and talk shows, a few programs for children, and music are examples of programs carried on audio sidebands. Some programs can be received only with a demodulator designed to pick up a special signal. An example is teletext which is a text and graphic medium. Thus, audio channels should be kept in mind as potential sources of graphics and text as well as sound.

Teleconferences: A growing service for companies, organizations and schools is conferencing or meetings by television, radio and or phone. Schools may find ways to

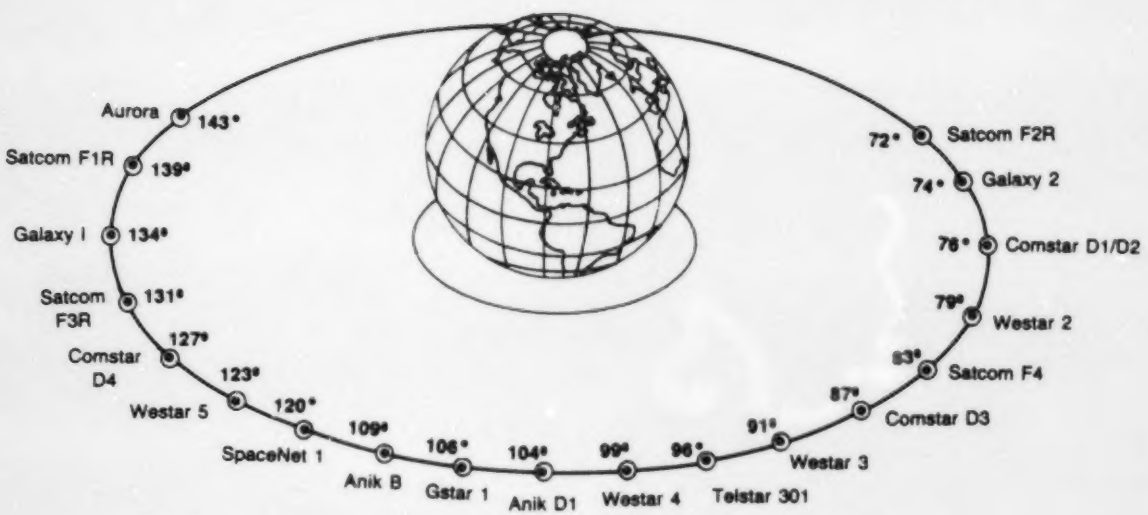


Figure 4
Programming for North America is delivered by a growing number of communications satellites positioned in the Clarke Belt over the equator. To receive signals from more than one, a movable dish and multi-channel receiver is required.

participate in teleconferencing by using their TVRO to see and hear presenters while also interacting with them by phone. Possible uses are for inservice, administrative orientation, seminars, public and community liaison, credit courses, and professional association services. Regular use will require specially designed facilities to maximize teleconferencing effectiveness.

Data: Computers can be interfaced with satellite services to allow schools to obtain computer programs or to download records, special data, library information and other messages commonly delivered by mail or phone lines. Regularly available and pertinent school information in this form is not yet easy to acquire from satellite and special local equipment in addition to the standard TVRO is necessary. However, this type of programming and service is expected to expand.

The Dish

A TVRO is usually noticed because of its signal receiving dish. (**See Figure 5.**) The dish has two major purposes: it gathers satellite signals and it focuses these signals onto a device called the feedhorn. The feedhorn eventually directs the signal to a receiver, which converts the signals so they can be seen, heard, or read directly or captured by computers, recorders, and television sets.

The dish is called the "satellite receiving antenna," but the actual antenna is much smaller. The dish itself reflects signals. The usual dish is frequently parabolic, but may be square, or some other shape. It is normally made of special wire mesh, fiberglass, or metal, sometimes covered by fiberglass. The satellite dish is aimed skyward. It is frequently mounted on the ground for stability, but it can be mounted on roofs, or other structures. The dish is an important part of the TVRO, but it is only one part of the receiver and feedhorn system. Dishes are positioned out of doors and must be impervious to weather. Their coating either absorbs or lets heat through rather than reflecting it because the less heat reflected to the feedhorn the better the reception.

Dishes may be permanently mounted or portable. They should be resistant to wind as their movement causes loss of signal while the receiver is operating. The solid face types, such as fiberglass, may also be subject to water accumulation and freezing in some climates.

Electromagnetic Noise

"Noise" is a term applied to unwanted electrical signals that interfer with TVRO systems, somewhat akin to static on the radio or "snow" on TV. Noise has two major sources—thermal energy (from the sun, space, and earth heat) and shot-noise from various electronic devices. Exposure to these noise sources can affect pictures, sound, and data quality. Snow, sparklies, confetti and hiss are names given to such picture and sound problems.

Technical specifications for TVROs deal with their ability to handle noise. A TVRO system is often rated by its NF (Noise Figure) and C/N (Carrier-to-Noise Ratio) as well as dish gain called VSWR (Voltage-Standing Wave Ratio).

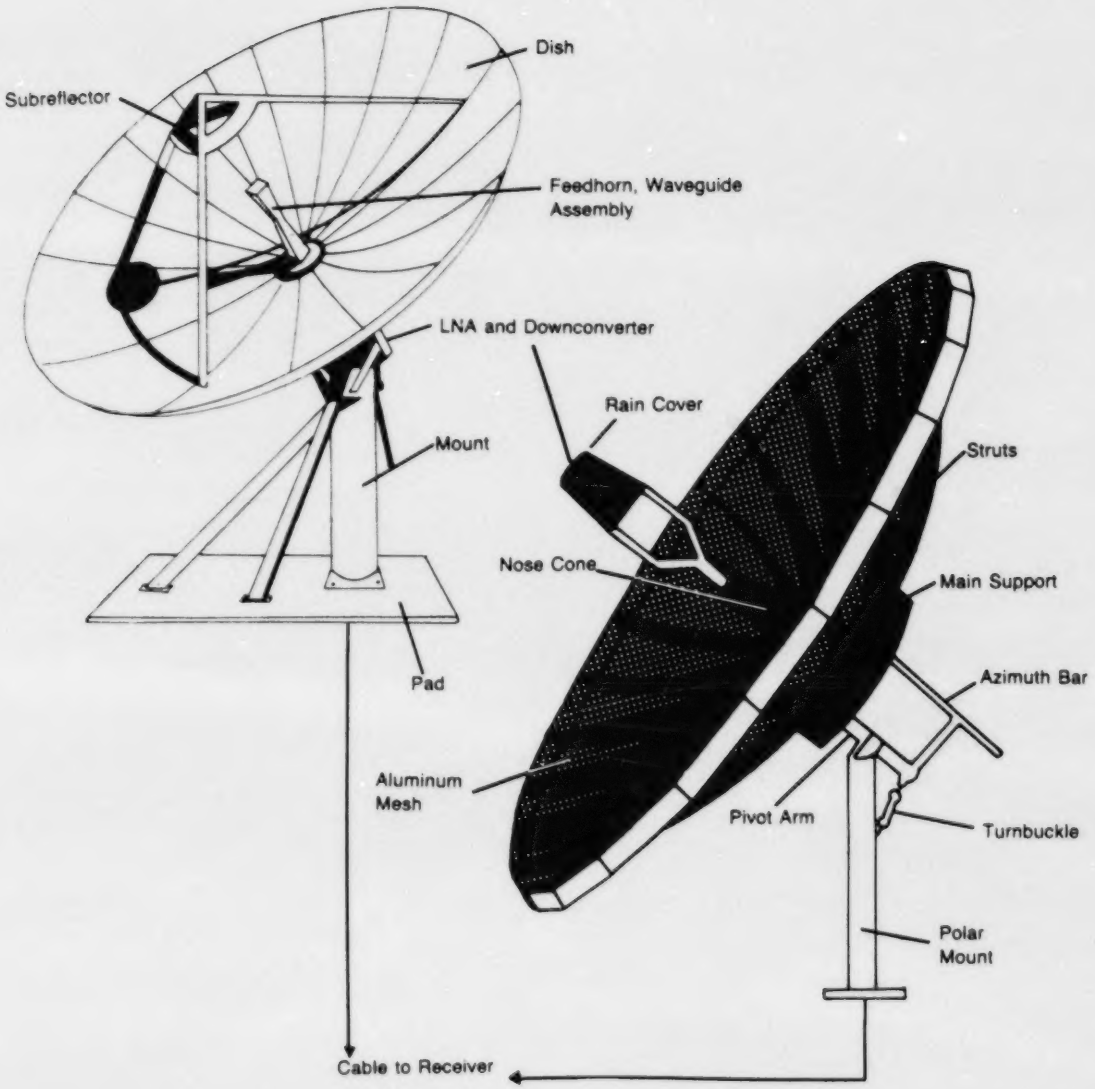


Figure 5
A typical TVRO has a reflector dish, feedhorn, antenna, low-noise amplifier and downconverter which connects to a receiver. There are many different types of dish, feedhorn, and the other components.

- VSWR is best as the ratio approaches one (1:1). A typical value for C-band dishes is 1:2.

- Gain, which is related to dish aperture, usually ranges from 35dB to 45dB. The larger the dish the better the dB or gain.

- NF is the signal-to-noise ratio from an output to input. The less noise the better.

- The C/N compares downlink signal power to noise in decibels. The higher the C (carrier) and lower the N (noise) the better will be the picture, audio or data quality. Thus the larger the stated C is to the N in the ratio, the better.

Another characteristic is the capability to accept beamwidth. A dish can select signals from one satellite while rejecting others. A dedicated dish can select from only one or a few satellites while other types can select from many. Generally, the larger aperture (diameter) dishes are most selective.

Aesthetics

Dish installations for C-band reception tend to be obvious. The dishes must be large, from two to six meters, and sited in relatively clear-to-the-south space. School neighbors in some cases may be apprehensive about the appearance of the dish. Check your local zoning ordinances.

If a dish is painted with school name, mascot or other designs, special paint is required to prevent deterioration of signal.

Site Selection

A school district may find it desirable to have a TVRO at each campus, or if an inter-campus distribution system such as cable or microwave is in place, a master TVRO may be best. The TVRO site should not be more than 300 feet from the tuning/receiver components—the shorter the distance the better the signal quality. Three hundred feet is about the maximum for quality signals to be relayed over coaxial cable without additional costs for the system. The coaxial cable from dish to school (or other buildings) should be run underground. Coax encased in ¾" PVC pipe is an inexpensive method. Seal the pipe ends around the cable with flexible sealant to keep out water.

The site should be relatively clear and the sight path to satellites free of objects. It should not be in the path of nor under phone or microwave transmissions, nor under electric or phone lines. Try to pick an area out of the wind, not subject to the highest currents, and easy to reach in case of dust, snow or ice accumulation or high water. Height is usually desirable as it allows clearance from ground induced noise. In cases where roof mounting is planned, special support may be necessary for wind and weight loading. Weight is not normally a problem with TVRO dishes, but size may be. Mesh type dishes are less prone to wind stress and reflected heating. Protect the antenna site from vandalism and unwise access by the curious.

BEST COPY AVAILABLE

Dish Aiming

The dish must be positioned to clearly "see" a particular satellite. To see the satellite from North America the dish will face in a southerly direction because the satellites are parked in orbit over the equator. A dish can be permanently aimed or can be moved manually or mechanically, and remotely, to certain angles of elevation as well as horizontally. (**See Figure 5.**) A school dish might need to see only one particular satellite and thus would not require remote aiming options. On the other hand, an adjustable dish can turn in an arch to see various satellites and thus receive a variety of messages. Adjustable dishes are equipped with an actuator, or motorized drive which has a gauge on the receiver which will indicate when the dish is aimed close to selected satellites.

Aiming a dish towards the proper satellite requires knowledge of the heading and elevation of the satellite, longitude, latitude, and magnetic deviation of the site, and other information. Initial set-up and aiming should normally be done by a satellite receiver dealer or professional electronics agent. A dish misaimed by one degree can miss its intended satellite by 1,000 miles.

Dish Mounts

The mount is the attachment which supports the dish. It may be one of several types, including fixed, azimuth/elevation, or polar. For schools receiving from a single satellite, a fixed mount is less expensive and may be more practical. However, if aiming at various satellites is desired, a remotely controlled polar mount is preferable. Unless the dish is portable, it should normally be installed in a permanent location on a stable base, such as concrete pad or buried pole. The dish should not move when given a sturdy shake. Though C-band dishes can be mounted on buildings, complications may develop. Smaller K-band antennas may be more easily mounted on buildings. Check with your system vendor for best results.

The Feedhorn, Wave Guide, LNA, and Downconverter

In Figure 5, you can see a typical location of the feedhorn, and other parts of the TVRO. The feedhorn and converter units are sometimes located on a stalk in front of the reflector-dish and sometimes on the backside. The job of the dish is to reflect maximum signals to the feedhorn. The typical scaler type feedhorn must be placed exactly at the dish focal point. Its skyward sides are covered for protection from the elements.

The feedhorn gathers and directs the reflected signals into the waveguide. This is simply a tube or rectangular device of a certain length which contains an antenna at one end. (**See Figure 6.**) The antenna inside the waveguide (or horn as it is sometimes called) may be about an inch long. The antenna may be rotated by mechanical means to ensure that all channels from a particular satellite can be selected. The antenna is connected to coaxial cable which goes to the LNA (low noise amplifier). The LNA amplifies signals about 100,000 times including noise. The lower the Kelvins rating (a measure of heat/energy, k) of an LNA the better. Degrees Kelvin for the LNA commonly are 100 to 120 degrees. Another measure for quality in the LNA is its ratio of signal level to noise level, referred to as the G/T.

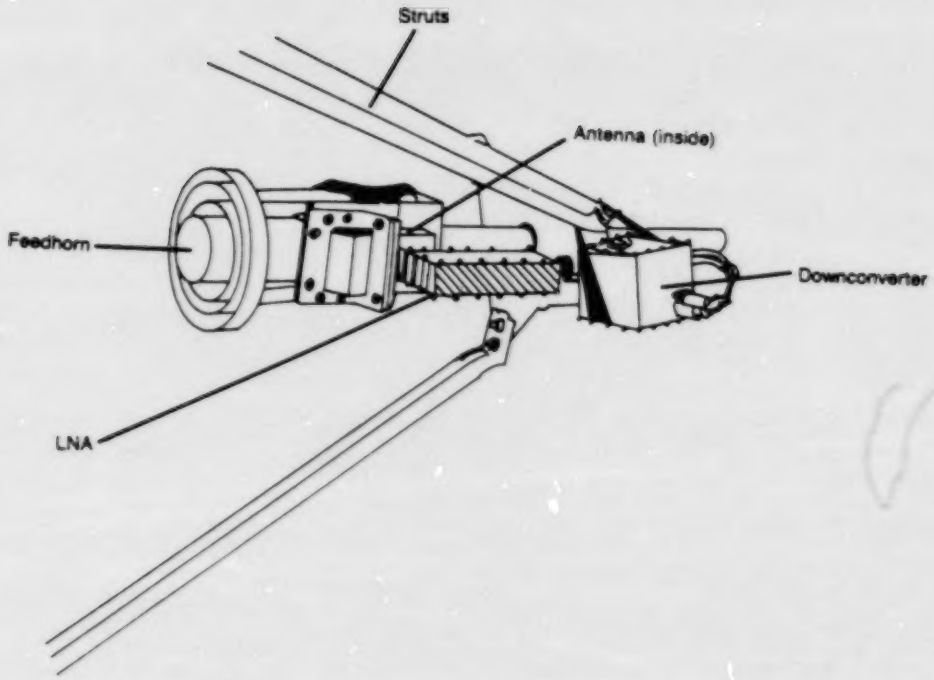


Figure 6
A feedhorn, low-noise amplifier, downconverter assembly may be located behind the dish or at the front. Reflected signals from the dish are focused into the feedhorn.

The amplified signal must then be converted from satellite frequencies (C-band or K-band) into frequencies that are feasible for coaxial cable. The downconverter is almost always located on the dish, close to the horn and out-of-doors. It must be tunable from a remote location. If the LNA and downconverter are integrated units, together they are called LNC (low noise converter). Installation, weatherproofing, and manufacturing are simplified; thus LNCs are usually less expensive than the separate components.

The downconverter puts signals into a coaxial cable running to the receiver, which is usually indoors. If the distance from converter to receiver is 100 feet or more, a line amplifier may be required. If more than one TV set or other device is operated from the system the signal will likely need to be amplified.

There are various kinds of downconverters. The general operation as previously described usually applies to a single channel transponder signal. For schools that need to handle several channels simultaneously, a block downconverter is used. This device converts a variety of satellite frequencies to the intermediate frequency required by a receiver so that it can feed several channels at once to various locations in the school.

Cables

Although several kinds of cable can be used to carry signals, normally coaxial cable is used. The best types depend on many factors, one of which is impedance, usually 75 ohms. An electronics specialist should determine the proper type to suit the installation.

Excess coaxial cable should be removed to improve signal strength; sharp bends should be avoided. In addition to coax cable for signal carriage, there must be wire to provide DC electrical current to motors, to the LNA, and to the downconverter at the dish. The electric lines can be encased in the same underground pipe as the coax.

Receivers

The receiver is actually a second stage in the converter process. Typically, the receiver is an electronic box with meters, knobs or buttons, connectors and switches. It converts signals from the low noise amplifier or low noise converter so they can be used with television sets, computers, radios, etc. Common functions of the receiver are channel selecting, audio tuning, metering of signal strength, switching, fine tuning, and scanning. A receiver may be designed for only one dedicated channel, or for many. A school using a single satellite transponder, i.e., one channel or just a few, will be able to save money by using a dedicated type receiver with fixed tuning. It will seldom require adjustments. However, a multi-channel receiver, or one that is frequency-agile, can tune from channel to channel, usually up to 24 channels. This tuning can be manual or remote automatic scanning. The prices increase as features increase. A TVRO can be no better than the receiver.

The signals can be further rebroadcast from the receiver to various rooms or other buildings if the proper equipment is installed. Apartment complexes, hotels, schools, etc., use this arrangement, referred to as SMATV, Satellite Master Antenna Television. Although SMATV installations are beyond the scope of this document, a school may wish to explore the need for various local electronic distribution systems. (**See Figure 1.**)

TVRO Equipment Warranty and Servicing

As with most equipment, a school should make sure that valid warranties are obtained with any TVRO installations. You may also wish to insure for liability, weather damage, and vandalism. Local service and reputable business firms should be used when possible to help assure speedy adjustments, repairs and other services.

Licenses and Registrations

The company that sells TVRO equipment can inform you of requirements or protection available under the Federal Communications Commission (FCC). FCC registration will likely require some engineering costs for site surveys, but may provide some protection against interference from other electronic signals in the future. This may be of particular importance for metropolitan areas and other places where radio, microwave, and other electromagnetic noise is abundant.

Costs

As with most equipment, the costs will vary widely depending on "bells and whistles" and capabilities. TVRO systems, particularly the C-band type, may range from as low as $900 to $15,000. It is wise to know what you are buying and to buy the best you can afford. Costs have dropped dramatically since about 1978 and should continue to decline. For K-band type TVRO systems, particularly for the dish and mount, the costs may be significantly lower than for C-band.

The Future

Telecommunications technology continues to change rapidly. As the technology becomes more sophisticated schools should expect to expend more energy and funds to compete with other information delivery systems. This decade may bring many new and some unexpected satellite services. Capacities for carrying more information on the same bandwidth, such as with compressed digital video and digital stereo sound, are already increasing. Text and graphics are becoming available via satellite at rates competitive with traditional delivery systems. New international agreements and services will both expand and limit the information to which the average citizen has access. More interfacing of computers by networks can be expected. Greater local control over an expanded range of capabilities such as hardcopy, information formatting, and data manipulation can be predicted. Modification of the classroom experience for students and teachers is likely through technology capability for capture-and-display, interactive instruction, and library retrieval. A variety of state-sponsored and private services can be anticipated. Configurations similar to that in Figure 7 may become widespread.

The essential consideration for schools will be the nature of the services and their appropriateness to schooling. As these technological and service changes continue, the equipment of today, such as the TVRO, may require modification or complete replacement. The dish should remain useful through the end of the decade, but other components of the TVRO system may not.

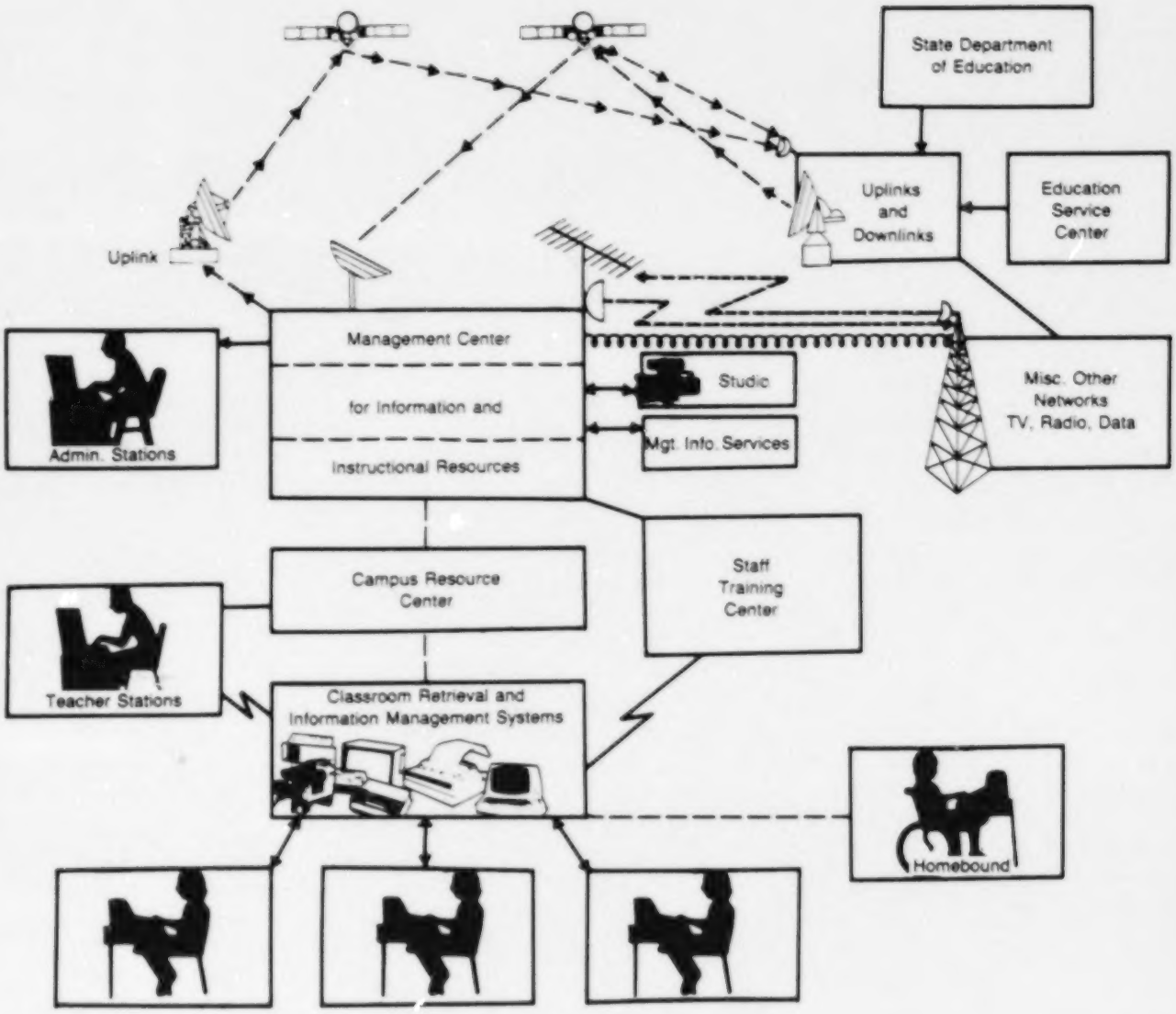


Figure 7
In the future there may be a variety of educational services and technologic configurations for delivery of instruction.

Self-Test and Short Answers About Satellite Receiving Systems

1. **What is a TVRO system?**

   Basically, it's a reflector dish with feedhorn, antenna, cable and receiver/tuner which can pick up signals from a communications satellite. TVRO means Television Receive Only, although such a system can also pick up data and voice.

2. **Is it the same as a home satellite receiver installation?**

   Yes, basically, but a school should choose the higher quality systems to ensure best results.

3. **Can school Personnel install one?**

   Yes, with some prior knowledge. However, a professional installation is recommended.

4. **How do we know what programs or services are available via satellite?**

   There are several magazines which give weekly or monthly programming, particularly for television.

5. **Assuming that the equipment is good, is the reception from a TVRO good?**

   Usually reception is better than you are regularly used to. There may be some deterioration of signals during a heavy rain.

6. **Can a school use a transportable TVRO installation or a portable earth station uplink?**

   Yes, both send and receive transportable systems are on the market. Portables are often rented for temporary projects and may also be appropriate for other projects. However, the rental costs for transportables will soon pay for a TVRO, and the cost for earth station uplink is substantially higher than for a receiver-only system. Usually, uplinking for broadband, that is TV, is quite expensive. Uplinks to send data and voice are much less expensive. When a school requires capability to send as well as receive messages it should compare costs for similar capabilities via terrestrial telecommunications systems.

7. **Is it legal?**

   For home use there seem to be few restrictions. However, schools should observe copyright requirements and be sensitive to issues surrounding SMATV (Satellite Master Antenna Television). No school fees should be collected for viewing or other use of the programs received without permission from copyright owners.

8. **Where can we put the TVRO dish?**

   Almost anywhere with a clear sight path and electromagnetic path to the south-southwest sky. It should also be secure from unauthorized access.

9. How do we know if there is a clear electromagnetic path?

A professional site check (survey) is best because tests must be done to check for possible interferences from microwave. Shielding can be installed for problem situations.

10. Is an FCC license needed for a TVRO?

Consult with your system installer. Be aware that a license will help protect your reception path from future interference. The K-band spectrum is less congested than C-band, but the programming for K-band satellites is presently very limited. An uplink definitely requires FCC approval.

11. Is a TVRO worth the cost to a school?

That depends on your school program and your judgment of the programs and information you can receive via the various orbiting satellites. Careful study of programming availability is a major first step in planning for school TVRO systems. In some cases, it may be the only viable alternative for a school to provide television or other instructional opportunities for students.

12. Is it smart to install a TVRO right away, considering the rapid changes in technology?

This technology seems destined to eventually play a major role in communications among Texas public schools. Administrative, inservice, instructional and library services may be offered. However, the present choices of TVRO sytems may not be compatible with eventual telecommunication systems. Therefore, careful consideration of TVRO system acquisition should be the rule during 1985-88.

13. Should schools subscribe to private satellite services?

Careful consideration of costs, alternatives and possible future state sponsored communications services would be wise. However, in lieu of alternative systems, services or directives, a district should plan carefully and move ahead where a need exists for acquiring satellite services.

Glossary

Actuator: A motor that moves the dish to focus on the selected satellite.

Aperture: Same as diameter of a parabolic dish antenna.

Azimuth: The angle left or right of true north.

Bird: The Communications Satellite.

C-band: A designated range of radio frequencies on a continuum of electromagnetic waves. Usually the satellite-to-earth frequency range is from 3.7 to 4.2 GHz (gigahertz).

C/N or C/NR: Carrier to noise ratio. The ratio of signal power to noise power in a satellite system, usually expressed as a power ratio in dB (decibels).

DBS: Direct Broadcasting System. Usually operating in the Ku-band at around 12 GHz (gigahertz). The receiver dish diameters usually range from about one to six feet. DBS is designed to be received directly at user sites as contrasted with intermediary reception sites such as TV stations, cable headends, SMATV and other such redistribution systems.

Decibel (dB): The ratio of two power levels, used as a measurement of gains or losses in a system.

Downconverter: The amplified satellite signal is sent from the LNA via a coaxial cable to an electronic box called the downconverter. The downconverter reduces the GHz signal to a much lower frequency, called the intermediate frequency (IF). This signal is sent to the receiver.

Downlink: The signal that comes down from a satellite to an earth station.

Earth Station: The terrestrial portion of a satellite link consisting of an antenna, amplifers and equipment for receiving and/or transmitting a satellite signal.

Feedhorn (also Feed or Horn): An apparatus to which the dish focuses received signals. The Feed directs the signals via a tube to the antenna. The signal then goes to the LNA where it is amplified, and then to the downconverter where it is changed to frequencies for the receiver.

Footprint: The area of the earth covered by signals beamed from a satellite.

Gain: The amplication ability of a device, expressed in the ratio of output power to input power, measured in dB.

Geostationary (Geosynchronous): In an orbit 22,300 miles above the equator a satellite will circle the earth at the same relative speed as the earth's rotation, causing the satellite to remain fixed in relation to a specific point on earth.

Gigahertz (GHz): A unit of frequency in cycles per second; one billion hertz.

Ku-band: A range of radio (microwave) frequencies higher in frequency than C-band on a continuum of electromagnetic waves. Usually they range from 11.7 to 12.5 GHz (gigahertz, a frequency designation) and 53 dBW to 66 dBW (a measure of relative signal power).

LNA: Low noise amplifier. A special amplifier that boosts the satellite signal while contributing a negligible amount of noise. The LNA is the first electronic stage that the signal encounters. The main function of the LNA is to amplify the collected satellite signals. The lower the noise temperature, the better the LNA; 100 to 120 degree LNAs are common. The lower the LNA degrees, the higher the costs.

Look-Angle: The angle at which an antenna must be aimed in order to "see" (receive the signal from) a particular satellite. Also called the position angle.

Parabolic Dish: A satellite antenna, usually bowl-shaped, that concentrates signals to a single focal point.

Polar Mount: A mount for the satellite dish that allows the dish to rotate in an arc to follow the orbit belt where geostationary satellites are parked.

SMATV: Satellite Master Antenna Television: A distribution system that feeds satellite signals to a hotel, motel, apartment complex, school rooms, etc. It is usually privately owned and is connected to only the buildings of the private owner.

S/N or S/NR: Signal to noise ratio. The ratio of the signal power to the noise power in a specified bandwidth, expressed in dBW. S/N = C/N + 37.5 dB.

Transponder: A microwave repeater (receiver and transmitter) in a satellite which amplifies and downconverts the frequency of a received band of signals. Domestic communications satellites use either 12 or 24 transponders, which usually have a 36 MHZ (megahertz) bandwidth.

TVRO: Television Receive Only. An earth station capable of receiving but not transmitting satellite TV signals.

Uplink: The signal sent from the transmitter on earth to the satellite.

Wind Loading: Wind pressure placed on a TVRO dish. Well designed dishes should be able to operate in 40 mph winds without noticeable picture degradation and be able to withstand winds up to 125 mph.

Bibliography

Books

A Satellite Receiver Primer for Schools, Bulletin No. 5133, Ralph Whiting (ed.). Wisconsin Department of Public Instruction, Madison, Wisconsin, 1984.

Easton, Anthony, *The Satellite TV Handbook*, Howard W. Sams & Co., 4300 West 62nd Street, Indianapolis, Indiana, 2983, 462688 $16.95

Long, Mark and Jeffrey Keating, *The World of Satellite Television*. The Book Publishing Co., Summertown, Tennessee, 1983 $8.95

Periodicals

Contain Programming Schedules or Satellite Information

Channel Guide (Weekly), Box 1633, Englewood, Colorado 80150, 1-800-654-3006, $39/year.

Coop's Satellite Digest, Satellite Television Technology, P. O. Box G, Arcadia, Oklahoma, 73001, (405) 396-2574.

Home Satellite T.V. Pre-Vue (Weekly), P. O. Box 31255, Billings, Montana, 59107, (406) 259-9067, $39.75/year.

Radio Electronics, June 1984, 200 Park Avenue South, Gernsback Publications Inc., New York, N.Y. 10003.

SAT Guide (Monthly), Comm Tek Publishing Co., Divison of Comm Teck, Inc., P. O. Box 9999, Dept. Q, Hailey, Idaho, 83333, (208) 788-4936 or 1-800-792-5541, $48/year.

Satellite TV Week (Weekly), P. O. Box 8, Memphis, Tennessee, 38101, (901) 521-1582, $48/year.

Satellite Dish Magazine (Bi-monthly), P. O. Box 8, Memphis, Tennessee 38101, (901) 521-1582, $48/year.

Satellite TV (Monthly), Triple D, Inc., P. O. Box 2348, Shelby, North Carolina 28105, (704) 482-9673, $24.95/year.

SATVISION, Satellite Television Industry Association (SPACE), 709 Pendleton St., Alexandria, Virginia 22314, $30/year members only. Consumer membership is $35.60 per year and includes SATVISION.

Satellite ORBIT, Comm Tek Publishing Co., P. O. Box 1048, Hailey, Idaho 83333, (208) 788-4936, Monthly, $48/year. A magazine of satellite entertainment and electronics. A companion magazine of programming from around the world, especially Latin America, is *Satellite ORBIT International*.

Satellite Communications (Monthly), Carditt Publishing Co., Englewood, Colorado 80111, $25/year.

Appendix One

Programming

Staying up to date on programming calls for constant diligence by local staff. Some networks realign their programming without notice. The scope of programming services is also regularly changing. The following is a sampling of 1984 programming sources.

Educational Programming

There are a number of channels which are devoted to educational or instructional programming. The content covers most curriculum areas and most levels K-12, college credit, health care, consumer information, science, public affairs, etc.

1. Nickelodeon—Pro-social programming for children and young adults, 6:00 a.m.-7:00 p.m. daily (central time).

2. ACSN: The Learning Channel—The Appalachian Community Service Network provides educational and instructional programming featuring college credit courses, 5:00 a.m.-3:00 p.m. daily. (subscription fee)

3. LIFETIME—Twenty-four hours daily of programming concerning health, relationships, self-development, and other self help topics. Currently no school use policy.

4. The Weather Channel—Continuously updated national and regional weather information. Educational segments on weather are shown regularly.

5. Modern Satellite Network (MSN)—The information channel, 9:00 a.m.-Noon, Monday-Friday. Weekly series on travel, business, consumer information, and health.

6. US Cable Network, Programming for women, 24 hours daily.

7. BizNet—Business related programming for the U. S. Chamber of Commerce, 5:00 a.m.-Noon.

8. Public Broadcasting System (PBS)—Four channels of PBS feeds including K-12 instructional programming and cultural programming.

9. The Disney Channel—Educational and entertainment, 7:00 a.m.-Midnight.

10. Learn Alaska TV Network—Educational programming of Alaska, 7:00 a.m.-10:00 p.m.

11. SPN (Satellite Program Network)—How-to programming, financial self-help, and entertainment, daily 24 hours.

12. Hospital Satellite Network—A network for the hospital community consisting of a unique blend of professional and patient programming, daily 24 hours.

13. HSC-TV/The BMAC Hour—Medical training by Brooke Army Medical Center, Academy of health Science, (occasional video).

14. The University Network (The Unchannel)—24 hours daily of nonsecular programming.

15. The Prime of Life Network—Programming targeted at the 45 and older audience, daily 3:00 p.m.-6:00 p.m.

16. Genesis Cable Storytime—Carries children's storybooks on the TV screen with color computer graphics accompanying a silent text, daily 24 hours.

17. The Silent Network—Entertainment and information programming in sign language, open captioning, and voice, Thursdays 5:00-7:00 p.m.

College Telecourses

College credit courses for college-bound juniors and seniors in high school, may be available by satellite. For example, International University Consortium, at the University of Maryland and The Learning Channel offer this service.

Such services may also be available for adults to earn a degree or credit of various sorts.

1. Adult Learning Service
   Public Broadcasting Service
   475 L'Enfant Plaza, SW
   Washington, DC 20024
   (202) 488-5360

2. Instructional Television Consortium
   American Association of Community and Junior Colleges
   One DuPont Circle, Suite 410
   Washington, DC 20036
   (202) 293-7050

3. The LEARNING Channel
   1200 New Hampshire Avenue NW, Suite 240
   Washington, DC 20036
   (202) 331-8100

Teacher Inservice

The Learning Channel and some local or other institutions provide teacher inservice programs. These programs provide accompanying printed material which may allow districts to individualize inservice programs. Examples include topics such as Social Problems in the Classroom, Human Relations and School Discipline, Strategies of Effective Teaching, and Stress.

Public Affairs

Live daily coverage of the U. S. House of Representatives, the Canadian Parliament and a NASA channel is available.

1. C-SPAN—Live coverage of the U. S. House of Representatives. It also covers related Congressional hearings and events. There is also a call-in show for high school students.

2. NASA Contract Channel—Coordinates video between the various control centers. Space shuttle missions can be seen live and unedited.

3. CBC Parliamentary Network, (French language edition)—Daily live coverage of the Canadian House of Commons.

4. CBC Parliamentary Network, (English language edition)—Daily live coverage of the Canadian House of Commons.

5. DEMSAT—Democratic party satellite network, occasional programming.

Ethnic

Educational, cultural, ethnic, and entertainment features produced by and for minorities are available. Foreign language speaking skills can be improved by watching various foreign language programs.

1. Spanish Information Network (SIN)—Twenty-four hours daily of Spanish language programming with feeds from Mexico, Spain, Argentina, Chile, Puerto Rico, and Venezuela.

2. Satellite Program Network (SPN)—Three hours daily of French language programming created in France.

3. Galavision—Spanish feature films, sports, and other special events, Monday-Friday, 3:00 p.m.-3:00 a.m.

4. XEW-TV—Superstation from Mexico City.

5. Black Entertainment Television (BET)—Quality films, music performances, and theater featuring black entertainers, with additional coverage of public affairs, cooking, health, and sports. Programs directed toward children and women also provided, daily 7:00 p.m.-1:00 a.m.

6. CBC North,Canadian Broadcasting Corporation—French edition of national news, entertainment and information.

7. Northern Television Service of CBC North—Includes Native Indian video and radio broadcasting services with native language audio.

8. TCTV (French Canadian)—Includes entertainment programming in French. Scrambled signal requiring descrambler. One time $750 fee plus $25 monthly fee for schedule. On Anik D satellite.

Cultural

Several transponders carry a variety of entertainment from the performing arts. These programs include theater, ballet, opera, art cinema, dance, and classical music presentations.

1. Alpha Repertory Television Service (ARTS)—Carries evening programming in the fine arts, 8:00 p.m.-midnight.

2. PBS, Public Broadcasting System—Four channels.

3. Bravo—International films, award winning film festivals, and the performing arts, Monday-Friday—7:00 p.m.-5:00 a.m., Saturday and Sunday—4:00 p.m.-6:00 a.m.

News

1. Cable News Network (CNN)—In-depth national news with special sporting events, financial, and weather reports.

2. CNN Headline News—A continually updated report of the day's major stories.

3. Financial News Network (FNN)—Financial and business news, Monday-Friday—6:00 a.m.-6:00 p.m.

4. Independent Network News—Syndicated news service which provides regular mid-day news and evening broadcasts as well as financial and topical news programs on the weekends.

Appendix Two

Programming: Management and Fees

In Texas each district must develop its own processes and guidelines for managing instructional informaton that it may access from satellites. These include policies and processes for instructional materials selection, distribution, fees, acquisition of rights, and other elements associated with electronic information delivery.

Appendix One lists some sources of TV programs. Exact fees, conditions for regular use and other such details change often. No attempt to cite such details is made in this document due to the probability of immediate obsolesence. Also, no attempt has been made to identify sources of data, phone messages, or audio (radio) information. The bulk of current satellite bandspace is television. At present it represents most of the curriculum material of interest to schools. Maintaining a current knowledge about programming available on any given satellite transponder, and whether or not fees are required, fee amount, to whom they are paid and by when, can be a time consuming task. Ultimately responsibility for copyright infringement by school personnel or students lies with the district. However, the distributors of protected information also have a responsibility to inform the public regularly of limitations on the use of information which is readily accessible via satellite receiving equipment.

A school district that regularly uses information which it receives from satellites will usually find that a substantial effort can be required to make sure that quality and appropriate information are obtained. A satellite receiver is not a free license to use all information transmitted. Funds are required to pay someone to produce information delivered by satellite. Fees may be charged for use of some information, even that developed by public agencies. The sum of such fees to a large or moderate size school district could easily reach $15,000 per year. Compiled on a statewide basis, the figures can exceed millions of dollars. There is no central telecommunications authority to provide information about useful programs, fees, schedules, and channels. Therefore, districts may find it desirable to form consortia or contract to obtain specified aid. Options might include PBS stations, regional media services, commercial agents or state offices.

Not all information on satellite requires that fees be paid. There is a plethora of public information available from satellite. Schools have certain fair use rights to use much of the information as long as the uses are for illustrative purposes, for class assignments, and for teachable situations, and as long as complete programs aren't copied for year to year use. Perhaps information in TEA Bulletin#GE4 244 01 *Copyright: School and 'Fair Use,'* and sources such as *Off-Air Videotaping in Education: Copyright Issues, Decisions, Implications* by Ester R. Sinofsky, and *The Copyright Game* by Gary Becker, Instructional Computing Services, Seminole County Schools, Sanford Florida, will aid the persons who advise about district policy regarding instructional materials uses.

Information retrieval systems or library networks may deliver information by satellite to their clients. Network headquarters normally provides guidelines, procedures and requirements for use of system services. A school that is not an authorized client of such networks may find instances where the information is useful and can readily be received on the TVRO system. Each school district should check its practices to avoid illegal or unethical use. In principle the same procedures should apply in cases where electronic mail, computer data and other informational services happen to be delivered via satellite and can easily be accessed through school owned equipment. In the case of noninstructional information such as management data there may be less concern over unauthorized use because the bulk of such information transmitted by satellite may be irrelevant and therefore of no use to most schools.